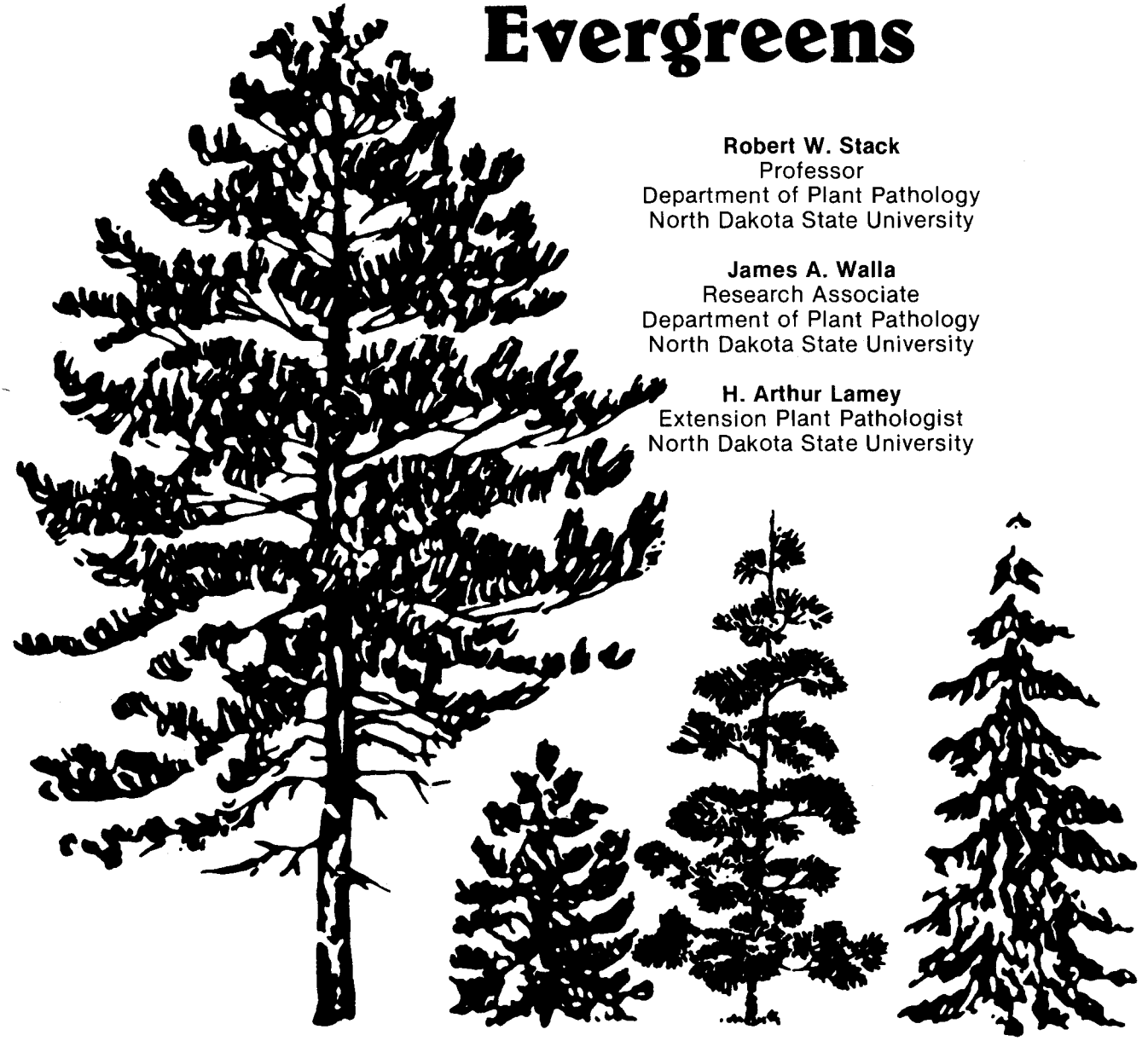
PP-789

Diseases and Related Problems of Evergreens



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Evergreens are grown in all areas in North Dakota. The primary uses of evergreens are in field and farmstead shelterbelts, parks, and residential landscape purposes. Production of Christmas trees is a growing industry in North Dakota, but at this time involves relatively few acres.

The problems described in this circular are in two categories: I) Environmental Injuries including winterkill, sunscorch, sunscald, animal injury and root disturbance; 2) Pathological Disorders (diseases) including Needle Casts, Shoot Blights, and Cankers and other Stem Diseases.

Environmental Injuries

Winter Injury (winter kill)

Winter injury occurs in late winter and early spring. Heavy coatings of ice and snow allowed to remain on trees and shrubs may cause serious branch breakage.

Control:

In landscape settings, plant trees in a location protected from build-ups of snow and ice or remove the build-ups as they occur. Injury often occurs in shelterbelts, where little can be done to prevent it. Alternate freezing and thawing of the soil may result in damage or death to the roots. To protect against root killing, water the trees deeply in late fall and during summer dry periods. The use of a mulch during winter months is important to conserve root moisture, prevent deep freezing, and prevent alternate freezing and thawing of the soil. Popular mulches used are straw (flax straw is best), bark chips, leaf mold, or well-rotted manure. These mulches are usually left in place over winter and either removed or worked into the soil in the spring. Bark chips may be left on year around.

Crown Dieback

When this condition is prevalent, tops of large trees (spruce, pine, etc.) may yellow and die back due to stressful growing conditions such as overly wet soil, chemicals in the soil, alkaline spots, drought, etc. Foliage on the trees begins to thin out and new shoot growth is stunted.

Control:

Water and fertilize landscape trees to maintain good vigor, and also mulch and water in late fall. Plant the trees in well drained, fertile soil and plant adapted species and varieties. (see Extension Bulletin No. 13, Trees and Shrubs for North Dakota, for a list of reliable winter-hardy evergreens). Control insects (see summary).

Make sure that the water used for irrigating the trees is not so high in sodium or other salts that the water will do more harm than good. Water quality can be a serious problem in many parts of the state.

Sunscorch (drought)

Foliage on the trees appears to be scorched as if by flame. The needles dry and turn brown from the tip down (Figure I). Tips of the branches begin to die back. Injury follows periods of very hot, dry, windy weather. Severe winter weather and spider mite injury cause similar symptoms. This condition is quite common in North Dakota among pine and spruce trees growing on exposed sites.

The combination of summer drought plus winter drying causes needles of spruces, especially Colorado spruce, to turn purplish in late winter and spring (compare Rhizosphaera needlecast, below).

Control:

Where possible, keep trees well watered during hot, dry periods. Control spider mites (see summary). Plant only hardy varieties.

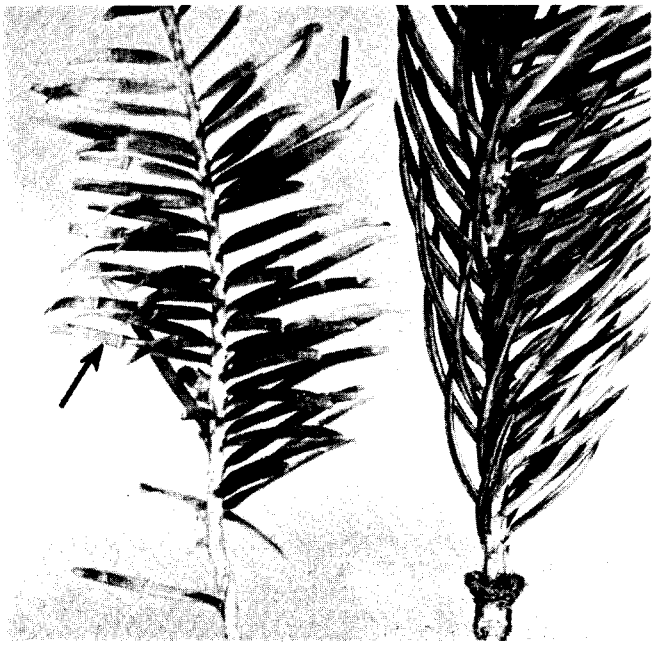

Figure 1. Sunscorch.

Sunscald (Bark scorch; winter drying; winter burn)

Two types of sun injury, winter and summer, are found in North Dakota. Winter sunscald is caused by a combination of high and low temperatures during the late winter or early spring. Temperatures on exposed surfaces of the shrubs or trees increase sufficiently to allow respiration in normally dormant cells. As the cells become active, water is given off. Because the soil is still frozen and roots are inactive, moisture in the active cells cannot be replaced. The result is drying of the tissue. The incidence of injury is usually much higher following a late snowfall, especially if followed by sunny weather and warm winds. Injuries localized on sun-exposed surfaces are classed as "winter sun scald"; this distinguishes the injury from "sunscorch" which is due to the drying effect of high summer temperatures. Winter injury is probably a much more common cause of leaf drying and limb cankers than summer injury in the northern regions.

Stages in severity of damage caused by sunscald are: first the killing of needletips, followed by the death of the entire needle, then killing of buds, the formation of cankers on small upper branches, and finally the formation of cankers on large branches which can kill the tree. Each stage in increased severity includes all previous stages of damage. Early stages of winter sunscald are frequently not observed. Following the period when injury occurs, affected tissues appear dull or discolored, and there may be some shrinkage due to drying. Foliage eventually turns brown (Figure 2) and drops. If branches are killed, the bark loosens from the wood and the brown, dead portions can be readily peeled from the underlying wood. This wood may also be discolored. With severe injuries, the bark soon splits and cracks. The final result is weathering and peeling of the bark to produce an open wound. Moderate types of winter sunscald are confined to small upper branches on the southwest face of the plant. The very severely injured trees or shrubs may die later in the season; those less severely injured will heal and survive.

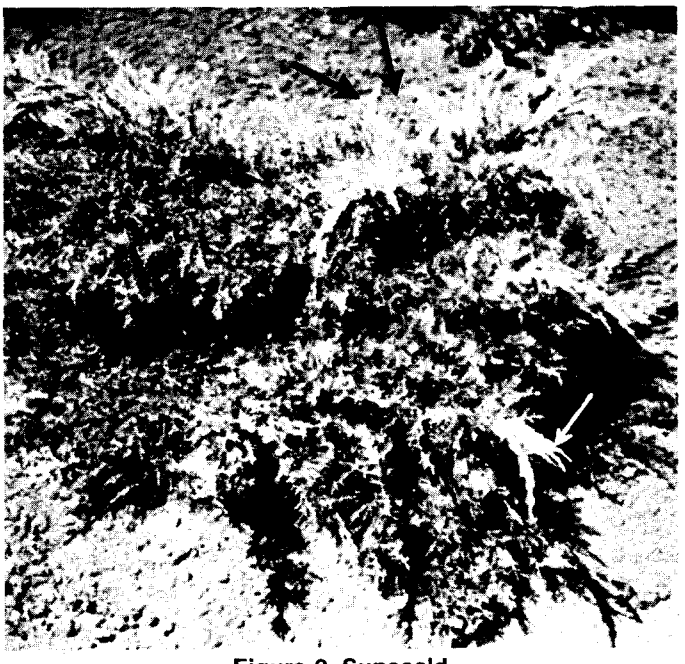

Figure 2. Sunscald.

Control:

When sunscald occurs frequently, follow practices in home plantings which prevent excessive overheating of the sun-exposed surfaces. Board, lath or burlap screens may be made to shade exposed surfaces. A darkly painted house does not reflect sun's rays as readily as light colored siding. Remove all dead branches after growth starts in the spring. Control mites with a recommended miticide (see summary). Fertilize trees in the spring to stimulate growth. Keep trees well watered during dry periods in summer and fall.

For shelterbelt trees, maintain vigorous growth of trees and control insects or mites. Larger trees do not require cultivation; avoid cultivation which will damage roots or branches.

Animal Injury (urine damage)

Dead, oily foliage is seen near the base of the tree. The foliage is dark brown to black in color. This condition appears most often during winter months when snow covers the tree trunks and urine is deposited on the foliage. Low and medium shrubs such as Andorra, Pfitzer, Hetz and Savin junipers and arborvitae are most often damaged.

Control:

Try one or more commercial "dog off" sprays or pet repellents. Also protect shrubs with fencing or by covering with snow or some other type of cover. Confinement of male animals, when possible, eliminates the problem.

Root Disturbances

One of the most common and yet least recognized causes of tree problems is root disturbance, often associated with some sort of construction activity such as laying of pipe or cable, street widening, placing a new building in an older site or turning residential areas into parking lots.

Because young trees — and even moderately-sized ones — can be successfully transplanted, people sometimes think that root damage is of no consequence. An established tree has a wide, spreading root system. Loss of a substantial part of this root system will result in decline of the tree unless corrective measures are taken. Old or very

large trees seldom have sufficient regenerative capacity to survive major root damage, although it may take such a tree several years to die. Home builders or contractors frequently try to preserve trees by fencing off an area around them. This protects the trunk from damage but is of little help to the root system, which extends out well beyond the drip line of the tree crown. Excavation, even at a distance of 10 feet from the trunk of a large tree, may destroy 30 percent of the root system. Nor is major soil disturbance necessary for substantial injury. Cutting a narrow ditch for laying utility cable effectively disconnects the entire root system on that side of the tree.

Changes in grade will also damage tree root systems by upsetting the balance of air and water the roots need to survive. Soil compaction from heavy vehicles can kill roots. When tree roots are damaged by any of these causes, the tree begins to decline. The first symptoms may be leaf scorch. Later, twigs and shoots die back, then whole branches may die. Death of the tree may follow.

The development of "tree spades" and other heavy tree moving equipment has allowed nurseries to sell large specimen trees, particularly spruce and pine. When these have been grown in a tree nursery where regular root pruning has been practiced, the results are successful and the tree becomes established readily on its new site. All too often, however, specimen trees are moved from shelterbelts or other plantings where trees have grown undisturbed for years. Trees on such sites have diffuse, widely spread roots, most of which are lost when such a tree is moved, even with a large machine. Such a tree has a poorer chance to survive, especially if the new site is exposed to wind or the tree cannot be adequately irrigated.

Spruce trees and cultivation

Older spruce trees in established plantings often lose their lower branches, exposing a bare soil area around the tree. In this area tree roots are very close to the surface. Controlling weeds in this zone is sometimes a problem, but cultivating or tilling this area will cause serious root damage. Even the most shallow of cultivation in this zone will injure many feeder roots and may predispose the tree to other problems.

Do not cultivate under spruce trees. If only a few weeds are present, hoe out or pull by hand. A mulch of pine needles or other loose organic material will control weeds and also preserve soil moisture.

Some herbicides are labeled for use in shelterbelts; each label specifies the restrictions for use and which tree species are labeled. Weed killers (herbicides) can be especially damaging to spruce trees. Their shallow feeder roots make such use risky even with supposedly "safe" chemicals.

Control:

Protect tree root systems, not just the trunk, during construction. Prevent heavy equipment or traffic from travelling near trees. If this is unavoidable, aerate the soil immediately following such activity. Do not allow utility trenching near trees. Insist upon written guarantees by contractors working near valuable trees. If major root damage to large trees is unavoidable, consider removing the tree and replanting. Often the savings by this procedure will more than pay for specimen size replacements. Do not pave over tree root systems. Roots need oxygen to live!

If tree roots are damaged, careful pruning to balance top and roots can sometimes help the tree survive. Get the help of a professional arborist. Your city or state forester may recommend someone or offer direct assistance. Water and fertilize to promote vigorous growth.

Pathological Disorders

Foliage Diseases

Several diseases cause spotting, browning, and/or premature casting of needles of pines and spruces in North Dakota including ponderosa pine, red pine, Scots pine, Colorado spruce and Black Hills (white) spruce. Needle diseases seldom kill trees, but the reduction in healthy foliage lowers vigor. Spots, bands or discoloration on needles may be symptoms of needle disease infection, but may also occur in response to insect or mite injury, air pollution (including herbicides), cold temperatures, drought stress, or aging. The diseases discussed have not all been found in North Dakota, but have all been found in nearby states.

Pine Needle Blights

DOTHISTROMA NEEDLE BLIGHT caused by *Dothistroma pini* can infect all two or three needle pines, but only ponderosa and Austrian pines are highly susceptible. Early symptoms appear in late summer or early fall as deep green bands with a water-soaked appearance and as yellow or tan spots. The spots and bands turn brown to reddish-brown. The ends of infected needles gradually die and turn brown. Tiny black fruiting bodies develop near the infection band in late fall or the following spring. Infected needles drop prematurely. In the western United States, where the infected spots or bands are more red than in the Great Plains, this disease is called red band disease.

BROWN SPOT NEEDLE BLIGHT caused by *Scirrhia acicola* causes symptoms and damage similar to Dothistroma, including spots, bands, dead needle tips and fruiting bodies. Neither Dothistroma nor Brown Spot are serious in North Dakota.

CYCLANEUSMA NEEDLE CAST, caused by *Cyclaneusma minus* (formerly *Naemacyclus minor),* can infect ponderosa and Scots pines. Needles of all ages are susceptible. Infection can occur during any season, most often in the spring. First symptoms appear as small, light green spots which gradually lighten and coalesce, turning the entire needle a dusty yellow, often with distinct transverse brown bars. Symptoms on most infected needles develop in fall but can develop at any time. Needles are normally cast from the branches a few months after developing symptoms. In North Dakota, fruiting bodies (apothecia) usually develop after needles are cast. They appear as raised, off-white areas on dry needles and as swollen, yellow, waxy areas on moist needles (Figure 3A). Damage is caused by the presence of yellow needles and defoliation. The development of yellow needles in the fall is often confused with natural needle senescence. Presence of transverse brown bars on discolored needles and the development of typical fruiting bodies are diagnostic for Cyclaneusma. Economical chemical controls are not currently known.

LOPHODERMIUM NEEDLE CAST can infect ponderosa, red, and Scots pines. First symptoms are yellow to brown spots or bands on needles. Infected needles die and may drop before the normal time. Characteristic black, football-shaped fruiting bodies develop on dead needles (Figure 3B). Several species of Lophodermium occur in North Dakota or nearby states. Control measures taken depend on which species is present. Long-needled Scots pine varieties are more resistant to some species than short-needled varieties.

PINE NEEDLE RUST caused by *Coleosporium solidaginis* can infect all our pines but seldom causes severe damage. Infection of needles occurs in early fall. White fruiting structures erupt through the surface of needles in late spring. Heavily infected needles die and drop. Less heavily infected needles may produce fruiting structures again the following spring. Since this disease needs two hosts to complete its life cycle, control is by removal of nearby weedy alternate hosts (goldenrod, aster).

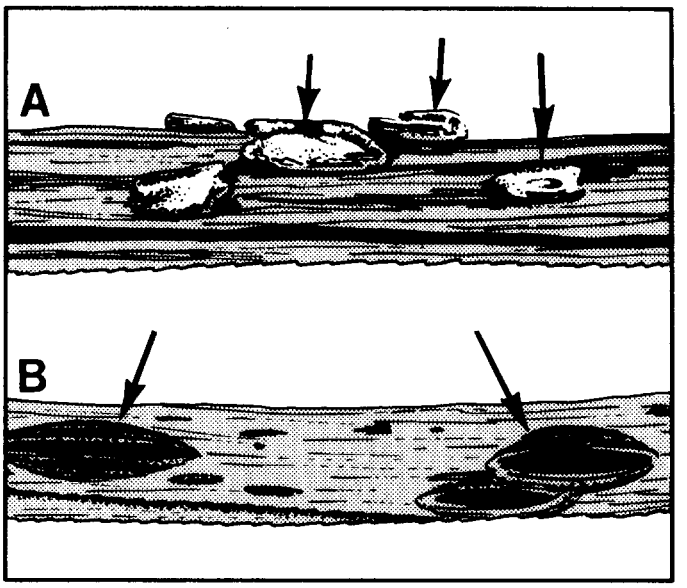

Figure 3. Close-up of pine needles showing fruiting structure (arrows):
A. Cyclaneusma
B. Lophodermium

Spruce Needle Blights

LIRULA NEEDLE BLIGHT caused by *Lirula macrospora* can infect all species of spruce. White (Black Hills) spruce is most commonly affected in North Dakota. All ages of needles are susceptible. Sporulation of the fungus is from late May through August, with peak releases from early June to mid-July. First symptoms appear as yellow bands which gradually become purplish-brown and expand over the entire needle in the fall, 15 to 17 months after infection. Large, smooth, black fruiting bodies (hysterothecia) develop along the length of the then reddish-brown needles the next spring, 23 to 25 months after infection (Figure 6A). Infected needles slowly lose color, become pale or tan and hysterothecia gradually mature and release spores the next spring and summer, 35 to 39 months after infection. Gray-tan needles with old hysterothecia may remain attached to branches for several years after sporulation (Figure 4). Damage is caused by the presence of discolored needles and reduced foliage, which reduce growth and aesthetic value. Lirula can be controlled by two properly timed applications of fungicide in each of three consecutive years.

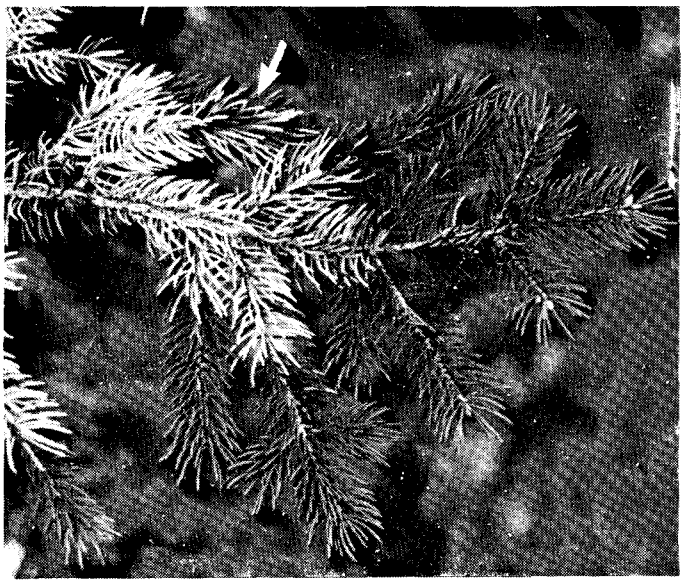

Figure 4. Dead older needles (arrow) caused by Lirula Needle Blight of spruce.

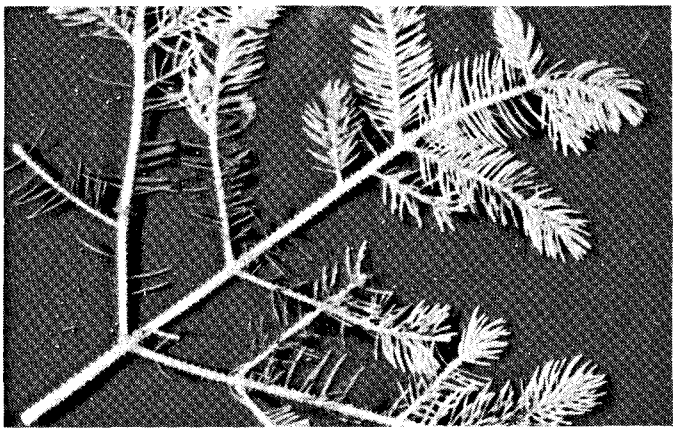

Figure 5. Loss of older needles caused by Rhizosphaera needlecast of spruce.

RHIZOSPHAERA NEEDLE CAST caused by *Rhizosphaera kalkhoffii* can infect several spruce species, but is primarily a problem on Colorado spruce in North Dakota. All ages of needles are susceptible. Needles are infected in late spring and early summer. Infected needles usually turn yellow and then purplish-brown in late winter. The following spring tiny fuzzy black fruiting bodies (pycnidia) (Figure 6B) appear. In mass, they may form characteristic black lines along the length of needles instead of the normal white lines. Infected needles drop off by mid to late summer of the year following infection (Figure 5). Damage is caused by the presence of dead discolored needles and reduced foliage. Rhizosphaera needle cast is currently the most widespread foliage disease of spruce in North Dakota. Rhizosphaera can be controlled by two properly timed applications of fungicide in each of two consecutive years.

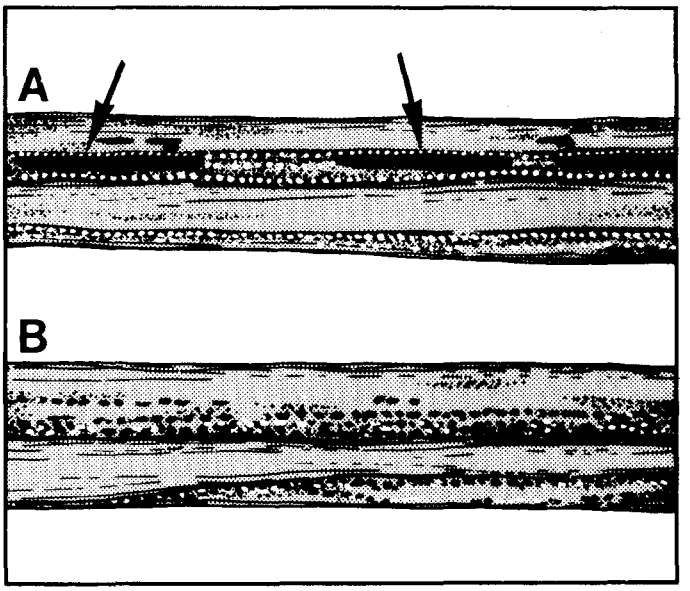

Figure 6. Close-up of spruce needles showing fruiting structures:

6A. Black elongate Lirula fruit bodies (hysterothecia) within the needle (arrows).

6B. Numerous tiny black rhizospaera pycnidia. These emerge through the white stomates.

Control of Pine and Spruce Needle Blights

Foliage diseases often occur in characteristic patterns. They can usually be distinguished from physiological or environmental problems because they occur mostly on the lower portion or on the north side of trees where needles remain wet longer. Usually the disease builds up on lower or inner parts of the tree before damaging the upper portions (Table 1).

To determine the cause of needle spots, bands or discoloration due to disease, it is necessary to find fruiting bodies of the particular fungi. Often these are hard to find or only appear at certain times of the year, and laboratory diagnosis is needed. Presence of colored spots or bands alone is not sufficient evidence to diagnose disease. Insect or mechanical damage can also result in such symptoms.

Cultural controls are often sufficient to prevent serious damage by needle diseases. These include maintaining tree vigor, planting resistant varieties

Table 1. Foliar symptoms and signs of common spruce problems.

	Disease/Disorder			
	Rhizosphaera Needle Cast	**Lirula Needle Blight**	**Cytospora Branch Canker**	**Environmental Injury**
Symptoms:	Needles turn red-brown or purple-brown in winter, drop by early summer.	Needles turn tan to light brown in fall, remain attached for 4-5 yr, becoming gray.	Whole branches die. All needles turn gray-yellow then brown. Abundant resin flow (Figure 8).	Needles turn brown in winter or after drought.
Affected part:	Older needles, current year needles remain green.	Older needles, current year needles remain green.	All needles on a branch equally affected. Individual branches scattered in lower part of tree affected first, later on all lower branches.	Most exposed parts show greatest injury.
Most severe on:	Lower branches, shady areas, Colorado Spruce.	Lower branches, shady areas, Black Hills Spruce.	Lower branches on crowded or stressed trees, Colorado Spruce.	Exposed or droughty sites, newly planted trees.
Look for physical presence of fungus (signs):	Tiny (1/100 in.) round black pycnidia emerge from needle stomates (white areas) in April-June (Figure 5-B).	Long (½ in.) black lines demark hysterothecia in older (3rd yr) dead needles (Figure 5-A).	No signs on needles. Under bark surface are round black structures (stromata) containing pycnidia (Figure 9).	No signs on needles. (Dead needles may support mold growth in wet weather.)
Controls:	Promote air circulation and avoid crowding. Fungicide sprays may help but timing is critical. Plant spruce trees in full sun.		Avoid crowding; thin out plantings by removing poor trees. Prune off infected branches in winter. Don't cultivate under spruce. Promote vigor.	Water deeply to promote good roots. Water during droughts. Protect newly transplanted trees from wind and sun.

when available, and promoting good air circulation around trees. Crowded, dense plantings create environmental conditions favorable for needle diseases. The needle disease fungi described here are often inhabitants on senescent older needles where they cause no problem. Only when they infect younger needles is there reason for concern.

Chemical controls may be needed if serious damage occurs. Spray materials and schedules are available for many of these diseases but identification of the needle disease involved is necessary for proper timing of protective sprays.

Shoot Blights

Shoot Blights of Juniper and Arborvitae

Shoot blights on junipers (red cedar) and blight on arborvitae may affect new needles, twigs or smaller branches. Affected plant parts turn light brown to reddish brown and later may turn ashen gray. Blight symptoms can be confused with damage from drought, the lesser cornstalk borer or rodent damage.

Thuja blight on arborvitae (*Thuja* sp.), caused by the fungus *Pestalotia,* is seldom serious except where arbovitae is grown under crowded or dark conditions such as under dense shade of other trees or crowded among other conifers. Lower branches damaged by snow, ice or animal urine seem to be favorable for infection.

Juniper blight can be caused by one of three fungi: *Phomopsis, Cercospora or Kabatina.* A laboratory diagnosis is needed to confirm which blight pathogen is present.

Cercospora blight affects only the needles of eastern red cedar and Rocky Mountain juniper. Infection starts on the oldest needles on lower branches and spreads upward and outward. Infection occurs in early summer. Needles die by late summer and drop by mid-fall. Severely affected trees have tufts of foliage only on branch tips. Trees may be killed. Control is possible with two properly timed applications of fungicide.

Blight caused by *Phomopsis* or *Kabatina* may involve shoots and branches as well as foliage, so entire branch tips often die. Foliage on affected shoots often turns reddish-brown. Tiny black fruiting bodies form on killed shoots. Microscopic examination of the spores from these bodies is necessary for proper identification.

Control of Juniper and Thuja blights:

The following hardy juniper cultivars have been reported resistant to Phomopsis blight: *Juniperus chinensis* 'Iowa', 'Pfitzerana Aurea'; *J. communis* cvs., 'Repanda', var. depressa; and 'Depressa Aurea', *J. procumbens; J. sabina,* all cultivars; and *J. scopulorum* 'Silver King'. Other cultivars and species also show resistance but may not be reliably hardy in North Dakota. Varieties resistant to *Phomopsis* blight may not be resistant to *Cercospora* or *Kabatina.*

Keep the trees growing steadily. Prune and dispose of all blighted parts when the plants are dry. Avoid wounding when transplanting or cultivating. Space the plants for good air circulation and avoid overhead sprinkling. Under nursery conditions, destroy infected plants and apply fungicide at one week intervals during periods of active growth in late spring and late summer and fall according to label directions.

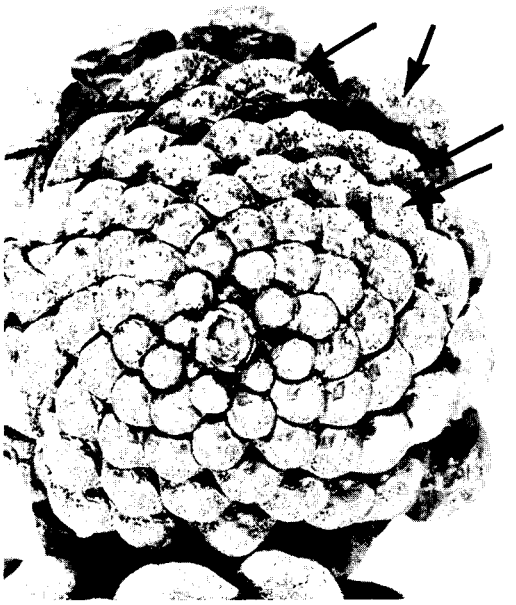

Figure 7. Diplodia on pine cone. Arrows point to tiny pycnidia erupting from cone scales.

Shoot Blights of Pines

DIPLODIA TIP BLIGHT

Diplodia tip blight of two and three needle pines, caused by the fungus *Sphaeropsis sapinea,* has greatly increased in many parts of the United States in recent years to become one of the most serious and devastating diseases of planted pines. In other states, Austrian pine and Japanese black pine are the most seriously damaged. In the Great Plains, Diplodia can be severe on Scots and ponderosa pines as well.

Symptoms

Before symptoms appear, Diplodia has usually reached high levels in the tree. This fungus infects the cones where it develops minute black pycnidia which appear as raised pimples on the cone scales (Figure 7). Spores are produced in these which spread the infection. Once many cones on the tree are infected, massive spore release can cause severe infection of needles and shoots. It is this 'tip blight' which causes the real damage and which is so conspicuous. While spores are released from pycnidia all through the season, most of the infection occurs during expansion of the new shoots following bud break. The fungus invades and kills growing shoots which then turn brown. Usually the older needles on the branch remain alive. Shoots are often killed just as buds expand so that the needles are only partly extended. The brown, partly-extended needles remain attached to the shoot tip. Shoots killed by Diplodia become resin soaked; this is one distinguishing symptom of this disease. Often the fungus fruits on the partly-expanded needles on killed shoot tips. If such needles are pulled from the sheath, the minute black pycnidia of Diplodia may be seen on the needle bases.

The blight begins with a few shoots on lower branches and moves throughout the tree. Eventually many of the new shoots may be killed. Diplodia-blighted trees are so disfigured as to lose much of their landscape or ornamental value. Loss of most of the lower branches also reduces the value of pines as wind breaks. In North Dakota, where pines are already under severe climatic stress, the loss of a significant proportion of new shoots may result in death of the trees. Because the fungus builds up on cones first, tip blight on windbreak and landscape trees usually does not appear until the trees reach reproductive age, usually 20 to 30 years. Severe damage can develop in nurseries and on young trees when infected older trees are nearby.

Symptoms can be confused with frost damage or tip moth damage.

Control:

Stressed trees are more susceptible to tip blight; maintain good fertility and water trees during droughts. Avoid overcrowding in new plantings; give trees room to develop. Do not plant young trees near old trees.

Pruning of blight-killed shoots will improve the tree's appearance but will not stop the spread because the spores for new infections are coming from the cones. Picking off all mature cones is a tedious but effective measure that will reduce the disease.

Because the period of peak susceptibility and infection is short, it is possible to protect new

growth with fungicide sprays. Spray two or three times at weekly intervals beginning as buds begin to swell (late April to mid May).

Other Shoot Blights

Two other important shoot blights of pines are found in adjacent states. Both are most serious on young plantings.

Red Pine Shoot blight is caused by the fungus *Sirococcus strobilinus*. The disease causes death of new shoots soon after expansion. Young infected shoots may bend over as they die forming characteristic 'shepherd's crooks'. Dead needles on older shoots droop downward from the shoot. Older parts of branches are seldom killed.

Scleroderris canker is wide-spread in the north central states but has not been reported from North Dakota. The needles on affected branch tips first turn orange-brown at the base while the tips remain green. Later all the needles turn brown. Current year's needles are affected first; often older season's needles remain unaffected until the canker girdles the stem. Needles on infected shoots tend to fold back along the stem. The wood under the bark shows a distinct greenish coloration. A laboratory diagnosis is needed to positively identify either of these shoot blights.

Figure 8. Cytospora canker — resin flow.

Figure 9. Cytospora canker — fruiting bodies in bark (outer portion removed).

Branch and Stem Diseases

Spruce Cytospora Canker

The fungus *Cytospora kunzei* causes a common and severe spruce canker. As the fungus invades the limbs of the tree, cankers are formed which cause the bark to decay. The result is dead foliage and limbs, particularly near the base of the tree. A flow of bluish resin from the diseased branches is the earliest symptom (Figure 8). When the outer bark surface is carefully pared off, the circular embedded black fruiting bodies of the fungus can be seen in the inner bark (Figure 9).

Cytospora is spread to healthy limbs or healthy trees by rain or contaminated pruning tools. Measures used to prevent sunscald also aid to prevent Cytospora because the fungus enters through such wounds.

Figure 10. Cytospora canker - dead and dying branches.

Control:

The most effective control measure for Cytospora canker is removal of infected branches in winter. At this time infected branches that are already dead will be brown, while dying branches will show a grayish-green or dull color (Figure 10). Infected branches never recover. Do not leave them in place hoping they will revive. Prune out all diseased branches before the first spring rain to prevent spores of *Cytospora*, which mature during the winter, from splashing to new infection sites on healthy branches. Dispose of all pruned-out branches away from spruce plantings.

Disinfect all pruning tools such as knives and saws by wiping them with rubbing alcohol. Treat pruning and other wounds with a wound dressing such as asphaltum or sulfur tree dressings.

The Cytospora canker fungus most readily attacks weak or shaded branches and trees. Therefore, remove weak branches and avoid crowding in plantings. When trees get too large and are crowded together consider thinning out some trees. Spruce trees are shallow rooted; do not cultivate under established spruce trees as this destroys fine feeder roots and weakens the tree.

Cytospora is most easily controlled by prevention. Keep trees well watered and fertilized. Maintain good drainage and air circulation. Avoid wounding trees. Prune during dry periods in summer and during winter. Do not bring or dispose of spruce Christmas trees or branches near healthy spruce plantings. Black Hills spruce seems less prone to Cytospora canker than Colorado spruce.

Pine Stem Rust

Although several stem rusts of pines are known, only one occurs in North Dakota. This is the Western Gall Rust or Pine-to-Pine Rust caused by *Endocronartium harknessii*. This fungus is a perennial parasite of pine stems. It causes the tree to form large, round galls at the site of infection (Figure 11).

The life cycle of western gall rust is simple. In late spring, masses of orange spores burst from the surface of the galls. These spores infect the new shoots or candles of the same or nearby pines. Gall formation takes at least one year to develop after infection. Galls may remain alive for many years and continue to enlarge as long as the branch is alive. If the branch or stem dies, so does the gall.

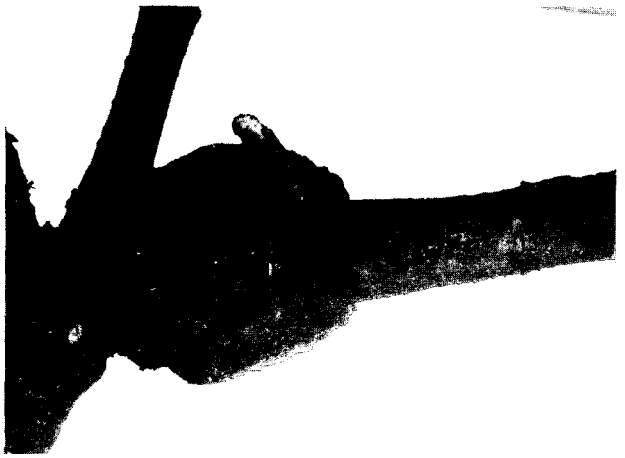

Figure 11. Large, woody gall on pine stem caused by western gall rust.

Western gall rust is present throughout North Dakota. It has been found in plantations, shelterbelts and on ornamental trees. Infected planting stock appears to have been the original source. The current high infection levels in some Christmas tree plantations are also attributable to use of infected stock purchased from nurseries where the rust is present.

In North Dakota, infections occur in so-called 'wave years'. In such wave years infection rates may be high, while in the intervening years few or no new infections will arise. This gives rise to the appearance of a series of even-aged galls on older trees. Wave years in North Dakota may be 5 to 7 years or more apart.

The damage done by western gall rust is related to the number of galls on a tree and their location. Heavy galling may kill occasional trees but usually does not. More often such trees may be stunted and show distorted growth. Trunks of trees with main stem galls may break off just above the gall. Main stem galls may cause death of the shoot above the gall. This results in a bushy, leaderless growth.

Ponderosa pine, jack pine, Scots pine, lodgepole pine and mugho pine are susceptible to western gall rust, but individual trees vary in susceptibility to infection. Often a tree completely free of infection will occur right next to a heavily-galled tree.

Control:

Inspect nursery stock for galls. Cull and destroy any galled seedlings found. In new plantations examine trees 1 to 2 years after planting and rogue out any galled trees which escaped earlier detection.

Certificates stating freedom from rust may be requested from suppliers but since few states enforce controls on movement of western gall rust-infected stock, such paper may be worthless. Most nurseries cull out obviously galled seedlings but some infected seedlings may slip past as not all infections occurring in the year of lifting will have developed into galls.

In Christmas tree plantations, do not plant new stock adjacent to older infected trees; cut and remove galled trees as early as practical. Fungicidal sprays applied at label rates during May and June to control foliar diseases, can also protect trees in the nursery from new gall rust infections. Three sprays at 10-day intervals are needed.

Cedar-Apple Rust and Related Rusts

Cedar-apple rust and related rusts are caused by species of *Gymnosporangium* that attack evergreen trees and shrubs in the juniper family. In

North Dakota these include eastern red cedar *(Juniperus virginiana)*, Rocky Mountain juniper *(J. scopulorum)*, creeping juniper *(J. horizontalis)*, common juniper *(J. communis)*, and certain exotic junipers planted as ornamentals.

Red-brown galls of cedar-apple rust form on eastern red cedar over a period of nearly two years. The mature galls ('cedar apples') produce orange gelatinous tendrils ('horns') during moist spring weather (Figure 12). The spores formed on these tendrils infect apple leaves and fruits. In *G. clavipes* (quince rust) the galls are perennial and may live for several years, producing new crops of spores each spring. Infection of Rocky Mountain juniper by juneberry rust *(Gymnosporangium nidus-avis)* results in 'witches brooms' or 'birds nests', which are stunted bushy groups of branches.

Figure 12. Cedar-apple rust gall on red cedar.

Like many other rust fungi, cedar-apple rust and other *Gymnosporangium* rusts alternate parasitism between two kinds of plants — one being the juniper. The alternate hosts (plants on which it completes its life cycle) are trees in the pome fruit group of the rose family, including apple, pear, quince, hawthorn, mountain ash, and juneberry.

Table 2 lists the *Gymnosporangium* species occurring in North Dakota and the evergreen and rosaceous (pome fruit) alternate hosts.

On pome fruit hosts, the symptoms and signs of these rusts are very characteristic. Symptoms develop on both leaves and fruits. Small, yellow-to-orange spots develop on the upper leaf surface shortly after bloom. Black dots soon appear in these spots. The infected spots are often thickened or blistered. In mid-summer tiny orange-colored tubes form on the lower leaf surface opposite the spots on the upper surface. These tubes split open and curl back (Figure 13). Heavy infection can result in severe defoliation. Spots on the fruits are similar except that the tubes are not always formed on apples while they are spectacular on juneberry and hawthorn.

Control:

Gymnosporangium rusts are seldom severe enough on juniper to warrant control. In a home garden, removal of galls by pruning out in late winter may give control.

Eastern red cedar (*Juniperus virginiana,* 'Canaert' and 'Glauca') and Rocky Mountain juniper (*J. scopulorum,* 'Hughes', 'Lakewood Globe', 'Medora', 'Moffet', 'Welch', 'Pathfinder', 'Cologreen', 'Platinum' and 'Gray Gleam') are generally susceptible to cedar apple rust. *J. chinensis sargentii* (Sargent

Table 2. Hosts of Gymnosporangium rusts.

	Juniper Host[1]	Pome Fruit Plant Part Attacked
Cedar-apple rust — *G. juniperi-virginianae*	ERC, RMJ	Leaves, fruits of apple.
Quince rust — *G. clavipes*	ERC, RMJ, CJ, BJ	Fruits, especially hawthorn.
Hawthorn rust — *G. globosum*	ERC, RMJ	Foliage, especially hawthorn; also on apples, mountain ash and pear.
Juneberry rust — *G. nidus-avis*	RMJ, ERC, CJ	Fruit, stems, leaves of juneberry, quince, apple, mountain ash.
(No common name) *G. bethelii*	RMJ	Hawthorn foliage.
(No common name) *G. clavariforme*	BJ	Juneberry, Hawthorn, Cotoneaster foliage.

[1]ERC = eastern red cedar *(Juniperus virginiana)*
RMJ = Rocky Mountain juniper *(J. scopulorum)*
CJ = creeping juniper *(J. horizontalis)*
BJ = common (Bush) juniper *(J. communis)*

Figure 13. Cedar-apple rust on apple leaf.

juniper) and many cultivars of *J. sabina* ('Arcadia', 'Skandia', 'Buffalo' and 'Broadmoor' junipers) are resistant to cedar apple rust *(G. juniperi-virginianae)* but may be susceptible to other *Gymosporangium* rusts which occur in North Dakota.

Since the rusts must alternate between a juniper host and a pome fruit host, do not plant these two together or near each other. If you wish to plant crabapples in the vicinity of junipers, use resistant varieties. Native crabapples are susceptible to cedar-apple rust; Asiatic crabapple varieties are generally resistant. 'Dolgo', 'Centennial', and Manchurian crabapples are resistant to rust.

Stem Decay and Heart Rot

In major lumber and pulpwood producing regions pines, spruces and other conifers suffer extensive losses from stem decay and rots. Timber-sized, mature trees are those most often affected by wood decay or heart rot.

Heart rot in living trees is caused by fungi which have the ability to decay wood. These fungi gain entrance to the heartwood of the tree through wounds, branch stubs, etc., which expose the bare wood. The fruiting bodies, or "conks", are common on trunks of decaying trees. Production of fruiting bodies is a sign of extensive decay in the stem. Heart rot fungi do not invade living wood of healthy trees. As long as the tree is growing vigorously the rot will be confined to a small central core of the trunk and the structural integrity of the tree will be maintained. If the tree is weakened for any other reason or fresh wood exposed by severe pruning or storm damage, then the decay fungi can advance to more and more wood. When this happens the tree may become unsafe and the risk of wind or storm breakage greatly increases.

Control:

Avoid pruning wounds which expose large areas of wood. Train trees when young so major branch removal will not be necessary later. Remove broken branch stubs following storm damage. Keep trees growing vigorously. Heart rot is primarily a disease of mature or over-mature trees. Except in native stands in southwestern North Dakota, few evergreen trees in North Dakota have yet reached the age where heart rot is likely to be a problem.

Root Rots

While root injury and disturbance (see earlier section) are most often the cause of root-related problems in evergreens in North Dakota, certain diseases do cause problems in some cases. Root diseases are difficult to diagnose because the affected parts are hidden below ground. Symptoms of root rot appear in above-ground tree parts as decline, dieback of shoots or branches, stunted growth and abnormal or discolored needles. These symptoms are not specific to root rot.

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